MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EPM4086 – DIGITAL CONTROL SYSTEMS

(RE)

11 MARCH 2016
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 4 Questions only.
2. Attempt **FOUR** out of **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. Table of Transform Pairs has been included in Appendix.

Question 1

(a) In digital control systems, what is "sampler and hold" ? [6 marks]

(b) Draw the block diagram for the representation of Sampler and Zero-Order Hold (ZOH). [3 marks]

(c) For the transfer function $G(z)$ models and inputs $r(k)$ given below, find the output response $y(k)$ as function of k

$$G(z) = \frac{6z-12}{(z-1)(z+4)} \text{ and } r(k) = f(x) = \begin{cases} 1; k = 1 \\ 0; k = 0,2,3,4, \ldots. \end{cases}$$

[16 marks]

Question 2

(a) Given the difference equation
$\boldsymbol{x(k) - x(k-1) + x(k-2) = e(k)}$
where $\boldsymbol{e(k) = 1}$, for $\boldsymbol{k \geq 0}$

Solve for $\boldsymbol{x(k)}$ as a function of $\boldsymbol{k}$, using z-tranform, find the values of $\boldsymbol{x(0), x(1)}$, and $\boldsymbol{x(2)}$. [7 marks]

(b) In the digital control system,
(i) What is "maximum overshoot"? [4 marks]
(ii) What is "bounded input bounded output"? [4 marks]

(c) Consider the block diagram of a digital control system as shown in Figure Q2. $\boldsymbol{r(t)}$ is the reference input and $\boldsymbol{w(t)}$ is the disturbance. Find the z-transform of the system output $Y(z)$ when $\boldsymbol{r(t) = 0}$ [10 marks]

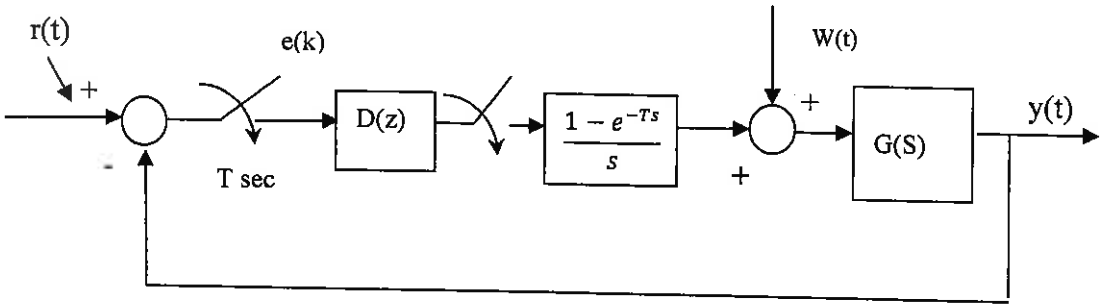

Figure Q2

Continued ...

Question 3

(a) Using Jury's stability test, find the stability of the system with the characteristic equation $F(z) = z^3 - 1.45z - 1.8z - 0.5$ [12 marks]

(b) For the discrete-time system modeled by the following dynamic equations.

$$x(k+1) = Ax(k) + Bu(k)$$
$$y(k) = Cx(k)$$

where $A = \begin{bmatrix} -1 & 1 \\ -0.7 & 5 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 2 \end{bmatrix}$, $C = [1 \quad 0]$

(i) Determine the transfer function $Y(z)/U(z)$. [6 marks]

(ii) Design the state diagram of the system. [7 marks]

Question 4

A system is shown in Figure Q4. The system is composed of two cascaded first-order subsystems, each of which is controllable and observable.

(i) Test the controllability and observability of the whole system. [10 marks]

(ii) Design the system such as the system is controllability and observability. [15 marks]

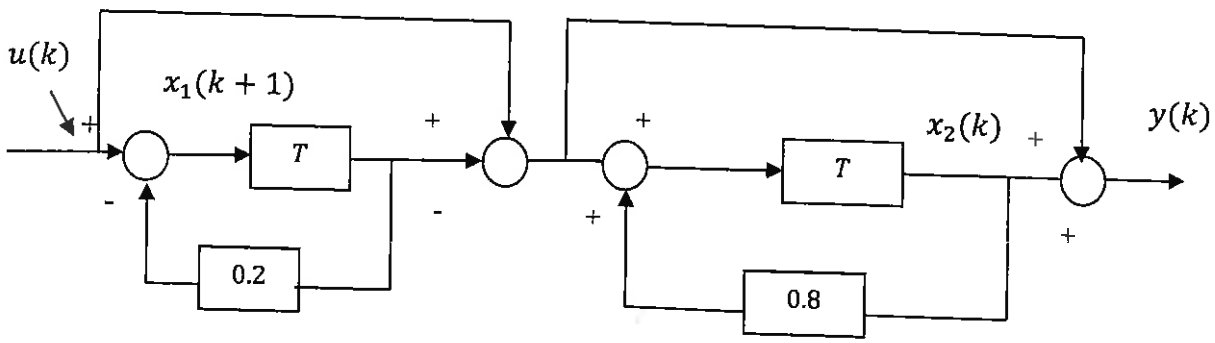

Figure Q4

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APPENDIX

TABLE OF TRANSFORM PAIRS

Time function $f(t); t>0$	Laplace Transform $F(s)$	Z-transform $F(z)$, T = Sampling time
$u_s(t)$	$1/s$	$z/(z-1)$
t	$1/s^2$	$Tz/(z-1)^2$
t^2	$2/s^3$	$T^2 z(z+1)/(z-1)^3$
ε^{-at}	$1/(s+a)$	$z/(z-\varepsilon^{-aT})$
$1-\varepsilon^{-at}$	$a/\{s(s+a)\}$	$z(1-\varepsilon^{-aT})/\{(z-1)(z-\varepsilon^{-aT})\}$
$t\varepsilon^{-at}$	$1/(s+a)^2$	$Tz\varepsilon^{-aT}/(z-\varepsilon^{-aT})^2$
$\sin at$	$a/(s^2+a^2)$	$z\sin aT/(z^2-2z\cos aT+1)$
$\cos at$	$s/(s^2+a^2)$	$z(z-\cos aT)/(z^2-2z\cos aT+1)$
$\varepsilon^{-at}\sin bt$	$b/\{(s+a)^2+b^2\}$	$z\varepsilon^{-aT}\sin bT/(z^2-2z\varepsilon^{-aT}\cos bT+\varepsilon^{-2aT})$
$\varepsilon^{-at}\cos bt$	$(s+a)/\{(s+a)^2+b^2\}$	$(z^2-z\varepsilon^{-aT}\cos bT)/(z^2-2z\varepsilon^{-aT}\cos bT+\varepsilon^{-2aT})$

End of Paper